IV. *On a hitherto unobserved Structure discovered in certain Trap Rocks in the County of Galway.* *By* ROBERT MALLET, Esq., M.R.I.A.

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THE town of Galway is built upon part of a vast mass of trap rock, lying in, and forming the embouchure of Lough Corrib, and which, running in a direction nearly N. N. E., is lost beneath the sea in Galway bay at one end, and towards the other may be traced to a considerable distance along the western shores of the lake. This immense deposit appears to be a trap-dyke of the largest class; it separates the mountain-limestone of Galway and the neighbouring counties, on the east, from the sienite of Cunnemara on the west.

The limestone, at its junction with the trap, when not covered and obscured by the sea or alluvial matter, is *tilted* up; the otherwise nearly level strata making angles of about eighteen degrees with the horizon. At one of these places, namely, in the demesne of Renville, near Oranmore, about four miles from Galway, a vein of cubical galena has been discovered, which offers a favourable prospect to the miner, much "gossan" forming the "crop" of the vein. The direction of the vein is nearly perpendicular to that of the trap-dyke.

The trap appears on the other side chiefly to overlie the sienite; but in some places it mingles with it, as though by fusion in almost insensible degrees. Both on the limestone and sienite sides, masses of each of these rocks are found enveloped in the trap;—the limestone being much altered in hardness and colour, its specific gravity and size of crystalline grain increased, and the rock occasionally converted into something allied to basanite or Lydian stone.

The existence of these imbedded masses of each of the neighbouring rocks, with their alteration of character, and the *tilting* up of the limestone strata, would seem to confirm the opinion that this deposition is a true trap-dyke. The

occurrence of limestone imbedded in trap is unusual. Kirwan, however, mentions that the "variolites" of Drac contain rounded masses of limestone and steatite.

Considerable excavations for a new dock, covering eight acres, are now in progress at Galway, and afford ample opportunity of examining the intimate structure of the trap rock. Its general surface, where laid bare, is about twelve feet above low water mark; it is rough, vesicular, and apparently water-worn, and rises every where into irregular "hummocks." The mass of the rock consists of greenstone of a dark leek-green colour, passing into purplish gray; rather fine-grained, and softer than usual, yielding, with difficulty, a whitish streak with steel. It absorbs water slightly, and becomes very dark-coloured when wet; is sonorous when in thin pieces; and has an average specific gravity of 2.87; its fracture is uneven, and sometimes imperfectly conchoidal. Its texture and colour are however extremely various, veins of several different constituents continually occurring in it, mixed and contorted in the most capricious manner—a single hand specimen often containing red granite and greenstone, passing into and varied in every possible way by hornblende, augite, schorl, albite, felspar, olivine, &c. Nearly in the centre of the surface of the rock exposed by excavation, there occurs a great vein of white hornstone rising with its laminæ vertical, and in something of a pyramidal form, in the midst of the trap. Its structure is lamellar, or pseudo-crystalline, with some perpendicular rifts; its substance is perfectly uniform, containing no imbedded minerals; its texture very hard and porcellaneous, with a high specific gravity; the longitudinal fracture slaty, and cross fracture splintery. At the surfaces of contact it is accurately moulded to the trap, but no where adherent to it. It appears to have been ejected after, and through the dyke itself, and is probably formed from simpler rocks, possibly slate, at a much greater depth.*

The minerals found imbedded in this trap-dyke are many and various. The following have been already collected, and others probably remain for future explorers :—

Mica,—brown and white, rarely.

Felspar,—in brown, red, and white crystals.

Albite,—large crystals in sienite, and druses in the hornstone.

* This hornstone has since been found to afford an excellent substitute for the costly "Turkey whetstones."

Olivine,—massive, and in small crystals.

Augite, Amphibole, Epidote,—in fine crystals; the latter also found on Mutton Island.

Apatite,—in microscopic crystals.

Chlorite,—indurated.

Adularia, Chalcedony,—met with only in small specimens.

Sulphate of Lime,—probably "*anhydrite*."

Baryto-calcite,—crystallized in large masses.

Arragonite.

Calcareous Spar.

Fluor Spar,—in purple cubic crystals, along with

Galena,—in cubes.

Iron Pyrites,—sometimes magnetic.

Specular Iron Ore,—in minute octahedral crystals.

A few of these minerals are rare in any habitat, others rare as occurring in trap rock. Of these fluor has hitherto been found in trap only in two instances,—at Gourock, in the Frith of Clyde, and at Papa Stour, one of the Shetlands. Anhydrous sulphate of lime has been found in a trap-dyke at Cave Hill, near Belfast.

Epidote is found in unusually fine crystals, imbedded in a red ochrey clay (apparently of decomposed trap) on Mutton Island, in Galway Bay, the site of the light-house. The island is low, and consists of sienite and trap, with a shingle beach of those rocks and limestone pebbles intermixed; epidote being also found in rolled pieces.

The iron pyrites is massive, and in crystals more or less perfect. The crystals appear to be hexagonal prisms, always imbedded, and sometimes magnetic.

By far the most singular circumstance, however, connected with this dyke, is the fact, that it possesses very generally a hidden nodular structure, of a description different from that hitherto found in any rock.

When a mass of this rock is separated by *the hammer*, it always breaks with the kind of fracture before described, and no trace of any thing unusual can be found. But in the process of *blasting*, the lines of least resistance in the mass seem to be discovered by the expansive force with a beautiful precision, and the fragments are found consisting of single or cohering nodules of trap, of various

sizes, imbedded in a matrix of a material similar to their own;—the texture, cohesion, colour, and frangibility, &c. of the nodule and matrix being so precisely alike, that when two or more nodules are found cohering, on being struck with a hammer they will as readily break through as separate. So entirely identical is the structure of the nodules and matrix, that the existence of the former could never have been ascertained or suspected without the aid of blasting; bringing to mind the ancient Grecian fable of the statue hidden in the yet unhewn block, revealed by the sculptor's chisel.

This nodular structure is confined to the more uniform portions of the dyke; or, if it ever existed in the more complex and variegated parts, it appears to have been obliterated by more perfect fusion,—many of the veined and compound specimens presenting the appearance of having *flowed* in a state of perfect fluidity.

The nodules are from eighteen inches in diameter to the size of a hazel nut; and the nodule and its seat, or nidus, may frequently be found and fitted together. They are usually pretty close together, and sometimes appear to have been pressed into actual contact,—their sides being flattened one against the other, and their surfaces of separation irregularly multilateral, like those of coherent bubbles of a mucilaginous fluid.

Many of the nodules present distinct indications of magnetic polarity. When an imbedded crystal (as of pyrites) occurs in a nodule, at its surface, it is always *limited by the latter*, or moulded to, and rendered imperfect by the matrix, and *vice versa;* no instance occurring of a crystal running from one into the other.

Foreign matter is in general much rarer in the nodule than in the matrix, and rarer in those parts of the dyke which possess the nodular structure, than in those which do not,—namely, the veined and variegated portions. In some cases the nodular structure passes insensibly into the solid homogeneous rock.

This nodular formation is essentially different from any other as yet described. The nodular, or orbicular granite of Corsica, and the south of France, consists of alternating layers of different crystallized minerals,—the crystals all converging to the centre of each spheroid, and imbedded in a matrix different in substance and arrangement from the nodule: it would appear to owe its formation to chemical rather than mechanical forces, and its origin is probably analogous to that of the quartz nodules found at Bonmahon, County Waterford, or to the formation of agates, hollow spar, onyx, and other minerals of accretion.

The *onion stone* of the Giant's Causeway, and some of the traps of Ayrshire, in Scotland, and of the south of Ireland, (together with the spherical trap of Shiant Island, mentioned by Dr. Maculloch,) consist of nodules, imbedded in a cement of a texture and composition totally different from their own; while each nodule, on being fractured, breaks into successive spherical shells, or coats, varying in hardness, and often in composition.

If speculation may be ventured upon the foregoing observations, it would seem to account for the phenomena to suppose, that the trap-dyke had been evolved beneath the sea at a temperature of fluidity; that in the violent agitation produced by the formation and ascent of steam, &c. portions of the fluid mass were projected upwards, became cooled in the water, and, falling again into the still imperfectly molten bed, were by its motions gradually re-enveloped, and again heated by contact nearly to its temperature. By these means (their texture being similar) an imperfect union would take place between the nodule and its matrix. When several of these nodules congregated, without intervening matter, they would cohere with flat surfaces, as before described; and when much more highly heated, (having fallen from a greater height, and so sinking deeper in the mass,) they would be again completely fused into the substance of the trap-rock, and thus present the case above alluded to of the gradual obliteration of nodular structure in some places.

It is even not an improbable conjecture, that the most capriciously variegated parts of this, and other similar traps and serpentines, may have been formed by the *soldering together* of nodules of diverse matter, either projected from different depths, or broken from the adjacent rocks forming the walls of the dyke; and it is possible that even the singular contortions in the stratification of mica-slate, &c. may have been produced by analogous means.

It is worthy of note, that these developments are entirely due to the *dissection* of the trap rock by the explosive force of gunpowder, but for which the discovery had never been made. This seems, then, to place in the hand of the geologist a new instrument for the prosecution of inquiries as to the intimate structure of unstratified rocks;—inquiries, which, should they reveal this nodular structure as more general than it is now known to be, will be likely to add much to our knowledge of the forces engaged in the production of rocks of igneous origin.